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Human Factors Study: Vector Map Evaluation for TAMMAC

MICHAEL E. TRENCHARD
STEPHANIE S. EDWARDS
WILLIAM K. CLARKE
MAURA C. LOHRENZ

Mapping, Charting, and Geodesy Branch
Marine Geosciences Division

CDR CHRISTOPHER COLLINS

Naval Reservist
NRL Science and Technology 206 Reserve Unit

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14. ABSTRACT

The Tactical Aircraft Moving Map Capability (TAMMAC) Program (NAVAIR PMA-209) has identified the use of vector map products as a high priority growth item. The TAMMAC Program will conduct an EMD effort during FY03-FY05 to incorporate the use of vector map data, specifically, the National Imagery and Mapping Agency's (NIMA) Vector Product Format (VPF) standard. In support of this effort, the Naval Research Laboratory was tasked to evaluate the potential functional benefits of vector map data and specific NIMA vector map products. This study focused on the functional aspect of using vector maps in the cockpit. The results from this effort are to help develop and refine the implementation requirements of vector maps as a growth item in TAMMAC and influence requirements for future map displays. In addition, the results are to help segregate the mission planning aspects of vector map mission planning from cockpit functional needs.

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HUMAN FACTORS STUDY: VECTOR MAP EVALUATION FOR TAMMAC

Objective

The Tactical Aircraft Moving Map Capability (TAMMAC) Program (NAVAIR PMA-209) [1] has identified the use of vector map products as a high priority growth item. The TAMMAC Program will conduct an EMD effort during FY03-FY05 to incorporate the use of vector map data, specifically, the National Imagery and Mapping Agency's (NIMA) Vector Product Format (VPF) standard [2]. In support of this effort, the Naval Research Laboratory was tasked to evaluate the potential functional benefits of vector map data and specific NIMA vector map products. This study focused on the functional aspect of using vector maps in the cockpit. The results from this effort are to help develop and refine the implementation requirements of vector maps as a growth item in TAMMAC and influence requirements for future map displays. In addition, the results are to help segregate the mission planning aspects of vector map mission planning from cockpit functional needs.

Background

Today's cockpit digital moving map is primarily driven by three geospatial databases:

1) CADRG (Compressed ARC Digitized Raster Graphics) [3]
2) CIB (Controlled Image Base) [4]
3) DTED (Digital Terrain Elevation Data) [5]

CADRG is a simple scanned, digital representation of a paper chart while CIB is a geo-registered imagery database. Both CADRG and CIB are "raster" databases and simply represent a pixel-by-pixel reproduction of a picture. DTED is a "gridded" database, where each element represents an elevation value. While TAMMAC supports all three of these geospatial databases, there is little ability to customize the map display for particular mission needs. For example, the level of detail in a CADRG map cannot be reduced to enhance the ability to view mission-specific overlays.

Vector maps, and specifically VPF standard map databases, are geospatial databases comprised of point, line, and area features that can be queried and displayed by geospatial location and thematic content (e.g. transportation, vegetation, industry). Also, vector map features may contain "meta-data", which is underlying information about particular map features. The ability to query a map on thematic content can provide the pilot with the ability to selectively add detail or remove detail from a map based on particular mission needs. While there is potential value in the added flexibility to design and customize a vector map, there is also the potential for increased aircrew workload to manage the level of flexibility provided in the cockpit. Customization and workload issues with vector maps were first identified in an NRL study conducted in 1995 to help define the baseline mapping requirements for the TAMMAC system [6].

Approach

An internet-based, on-line Vector Map survey was developed to gather Navy and Marine Corps aircrew preference data to evaluate functional aspects of vector maps in the cockpit and in mission planning. NRL used a similar internet-based survey technique as a lower-

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cost and less intrusive alternative to one-on-one pilot interviews in a pilot-centered study of aircrew mapping needs for MCM (Mine Counter Measures) and ASW (Anti-Submarine Warfare) missions [7,8]. The aircrew that responded to the Vector Map survey represented a full cross-section of Navy and Marine Corps Tactical and Rotary Wing platforms, and their associated missions, who currently have or are expected to have a requirement for cockpit Moving Map functionality. The survey is comprised of a registration page and two parts. Part 1 evaluates the *functional* aspects of vector maps and Part 2 evaluates the potential of specific NIMA VPF map products that are either currently available or in development.

Part 1 was comprised of an introduction page, six functional vector map demonstration pages, and a Part 1 rankings page. Five of the six demonstration pages allowed the participant to view a preset demo of a particular vector map function and/or interact with the vector map display. Once the particular function had been demonstrated, the participant was then asked to rate the function for use in both the cockpit and in mission planning. One demonstration page (VPF Draw) was only applicable for cockpit evaluation and could only be run as a preset demo. The VPF Draw demo was not a true functional vector map demonstration but rather a TAMMAC design issue. In addition to rating each Vector Map function, a "comments" section was included on each page to allow participants to add qualitative feedback on the Vector Map function shown. Finally, the participant was asked to rank the five vector map demonstrations in order of highest overall priority as a functional implementation. The vector map functions that were demonstrated are listed below:

Part 1: Vector Map Functions

- Customize Detail of Map Features
- Re-order Vector Layers
- Upright Text
- View Map Meta-Data
- Database Query
- Draw VPF vectors

Part 2 was comprised of an introduction page, six VPF product evaluation pages, and a final rankings page. Survey participants were asked to rate the usefulness of each VPF product by their primary (secondary and tertiary, if applicable) mission types they entered on the registration page and add optional qualitative comments. For each VPF product evaluation, a description of the map product was given which included: general description, intended uses, resolution, accuracy, and thematic content. Finally, the participants were asked to rank the six VPF products in order of highest priority for implementation (based on primary mission). The VPF data products that were evaluated are listed below:

Part 2: VPF Data Product Evaluations

- Digital Nautical Chart (DNC) [9]
- Digital Topographic Data (DTOP) [10]

- Foundation Feature Data (FFD) [11]
- Littoral Warfare Data (LWD) [12]
- Tactical Ocean Data (TOD) [13]
- Vector Map (VMap) [14]

Findings

a. Participant Profile

The primary platforms and associated missions that were identified by the aircrew participants are depicted in Table 1:

Platform	**Missions**	**# Of Participants** [1]
AV-8B	Primary - Air-to-Ground Combat (AGC); Secondary - Air-to-Air Combat (AAC) Other Missions – Training (TRNG), Forward Air Controller (Airborne) FAC(A), Close Air Support (CAS)	25
F/A-18 C/D/E/F	Primary – AAC; AGC (tied) Other Missions – ASUW, FAC(A), CSAR, LOG, TRNG, SWS, Mobility - FCLP	27
H-1 (AH-1W, UH-1N)	Primary – AGC; Secondary – FAC(A) Other Missions – CSAR, HVBSS, BD, SI, TRNG, MEDEVAC	19
H-60 (SH-60B, SH-60F, HH-60H)	Primary – Anti-Submarine Warfare (ASW and ASUW); Search and Rescue (SAR and CSAR) (tied) Other Missions: Undersea Warfare (USW), Surface Warfare (SUW) (including Surface Surveillance and Control (SSC) and Over-The-Horizon Targeting (OTH-T)), Combat Search and Rescue (CSAR), Helicopter Visit Board Search and Seizure (HVBSS), Search and Rescue (SAR)	16
Other	Various	7
Total		**94**

Table 1: Vector Map Survey Participants

Note 1: 86/94 participants completed both Part 1 and Part 2 of the survey.

The average flight hours in model and average overall flight hours for the participants are depicted in Figure 1:

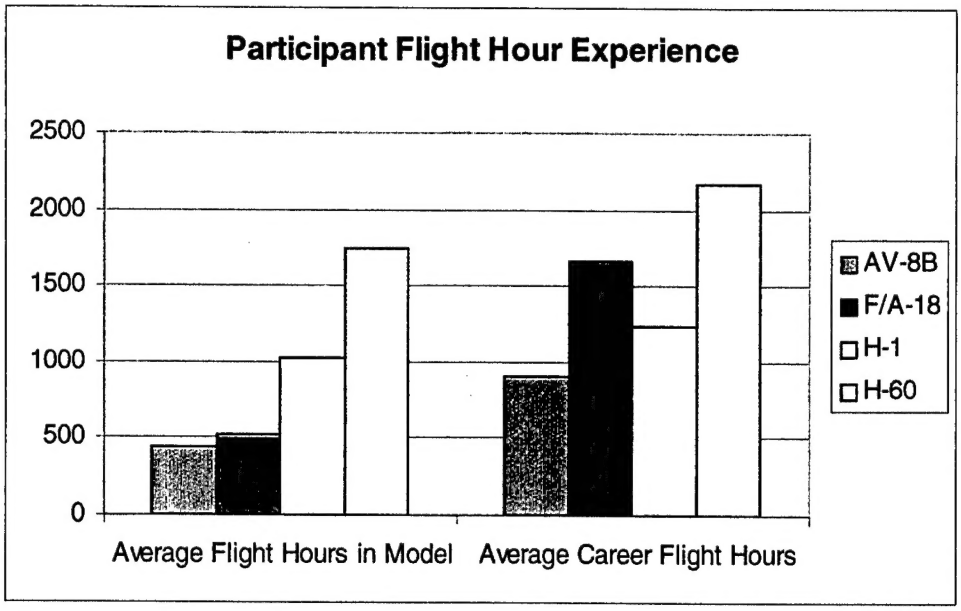

Figure 1: Participant Flight Hour Experience

The average moving map experience for the participants by platform is depicted in Figure 2. Table 2 describes the corresponding rating categories:

5.0	Currently Use/Very Experienced
4.0	Occasional Use in Cockpit
3.0	Limited Experience
2.0	Familiar with Concept
1.0	No Experience

Table 2: Moving Map Experience Ratings Scale

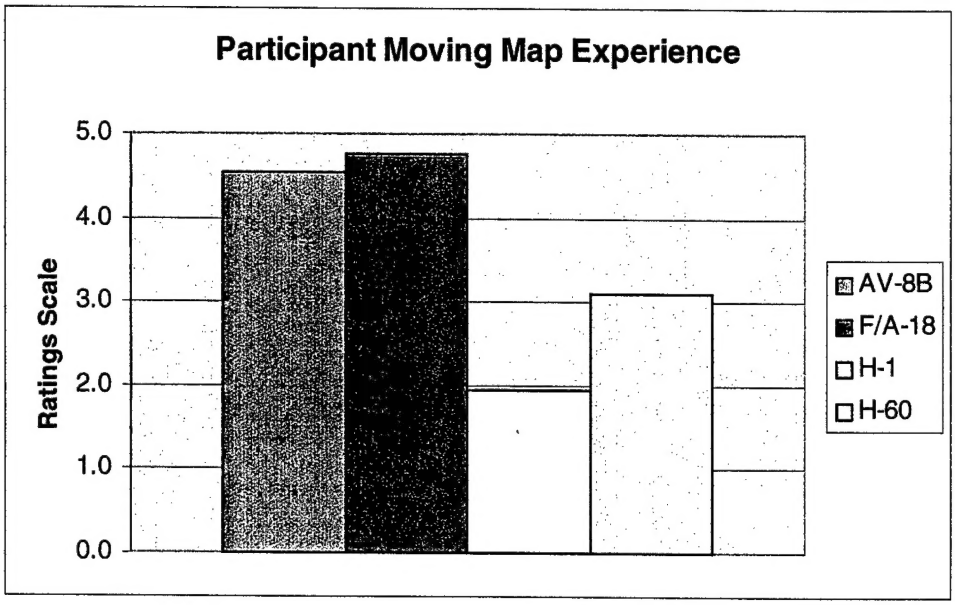

Figure 2: Participant Moving Map Experience

The results depicted in Table 2 are consistent with the level of familiarity with moving map systems that the participants identified in their respective profiles. Table 3 depicts those moving map and other systems that had been used by or are familiar to the participants. These are grouped by platform:

Platform	Moving Map Systems/Other Systems
AV-8B	AN/ASQ-196, PFPS, TAMMAC (AV-8B Engineer)
F/A-18	AN/ASQ-196, PFPS, TAMMAC
H-1	PFPS, TAMMAC (AH-1W)
H-60	PFPS, GADGHT [2], AN/ASQ-196, TAMMAC

Table 3: Participant Moving Map Systems/Other Systems Experience

Note 2. GADGHT is a digital kneeboard that uses Falconview to provide the aircrew with a limited moving map capability.

The survey also collected data on Night Vision Goggles (NVG) usage. Since the survey didn't explicitly address vector map issues in the context of NVGs, that data was omitted from this paper. However, a significant majority of aircrew currently used NVGs and rated themselves "very experienced". Any future moving map development issues will need to recognize the requirement to be compatible with NVG use.

b. Part 1 Analyses

Overall, the ability to customize details of map features (show/hide vector layers) was the highest priority across all the platforms collectively (67% - 31/46). The notable exception was the F/A-18, which listed the view meta-data function as the highest

priority more often than customize details of map features. However, those specific inputs were generally correlated with those participants with low flight time in model. Aircrew with high flight time in model generally selected the customize details of map features function as a higher priority than the view meta-data function. Table 4 depicts the percentages by individual platforms of aircrew that selected the customize details of map features function as the highest priority:

Platform	Percentage
AV-8B	73%
F/A-18	38%
H-1	86%
H-60	88%
Support	100%

Table 4: Customize Details of Map Features Prioritization Percentages

If both the 1st and 2nd highest priorities are included, 87% (40/46) of the participants identified the need to customize details of map features as a priority function.

AV-8B Comment: "*the ease of using the required Hands-On-Throttle-And-Stick (HOTAS) functions would determine how much this feature is used*"

The next level of priority for the AV-8B and F/A-18 platforms was the view meta-data function and the database query function. However, the re-order vector layers function was consistently identified as well as a high priority. For the F/A-18 platform, aircrew with low flight hour experience tended to prioritize the upright text function over the re-order vector layers function. For the H-1 and H-60 platforms, the next level of priority was the ability to re-order vector layers followed by the upright text function.

H-1 Comment: "*need to ensure that upright text will deconflict with existing waypoints/tactical symbology*"

H-1 Comment: "*vector maps need to display MGRS in addition to Latitude/Longitude (L/L)*"

F/A-18 Comment: "*non-rotating text may provide orientation to North for some aircrews*"

AV-8B Comment: "*first letter of rotating text should remain near icon on moving map to minimize confusion*"

The database query function was often rated as a low priority function across all the platforms. However, there were a number of comments that highlighted the importance of this feature during emergencies, particularly in trying to identify an appropriate airfield

for an emergency landing or bingo. Specific low priority functions by platform are as follows:

- AV-8B – lowest priority functions were very inconsistent, with the upright text, re-order vector layers, view meta-data and database query functions all being rated low by various participants. The upright text function was generally the lowest priority for aircrew with high flight experience, and the re-order vector layers function and view meta-data functions were generally the lowest priorities for aircrew with low flight experience.
- F/A-18 – lowest priority functions were inconsistent, but generally upright text was the lowest priority. For aircrew with low flight hour experience, the customize details of map features function was generally rated as a low priority.
- H-1 – view meta-data and database query functions were generally rated as the lowest priority functions, but upright text was also rated fairly low by some aircrew.
- H-60 – view meta-data and database query were generally rated as the lowest priority functions.
- Support – upright text and database query functions were rated the lowest priority functions.

H-60 Comment: "*meta-data would be very useful in ASW where bottom type, water depth, etc., critical for successful ASW prosecution. Also incorporating power line height and tower height in meta-data would be quite useful in both planning and in the cockpit*"

F/A-18 Comment: "*inherent declutter capability due to accessible chart data (via database query) would aid SA during high workload tasks by eliminating non-critical map information*"

F/A-18 Comment: "*the database query function will be useful for quick confirmation of terrain description*"

F/A-18 Comment: "*pre-mission planning should allow the aircrew to set re-order profiles that can be accessed during flight, thereby minimizing aircrew workload on re-ordering*"

Generally, it appears that both the AV-8B and F/A-18 platforms desire the ability to access map data via the view meta-data and database query functions more than the upright text function while conducting their missions. In addition, pilot profiles for re-ordering vector layers was highly desired. This probably correlates to the highly dynamic nature of conducting the AGC mission, with associated minimum response times, and the need to minimize additional task complexity while interacting with the moving map.

For the H-1 and H-60 communities, their preference for upright text and re-ordering of vector layers is probably consistent with their detailed map usage during mission execution. This would be consistent with mission execution that relies significantly on detailed map reading and track correlation for threat avoidance, terrain avoidance, and

navigation – due to the close proximity of their normal operational altitudes to land or water. In addition, the lower priority for the meta-data function appears to be consistent with associated comments that this function supports detailed map study, which would generally occur during the mission planning/mission rehearsal phase and not during mission execution

Lastly, an overwhelming majority of the participants preferred the "draw as you go" approach for drawing VPF vectors. There were some associated comments that a partial drawing may still provide enough immediate information to quickly enhance cockpit situational awareness (SA). Overall, most participants stated that any delay should be minimized.

The relative ratings by platform[3] for each of the five Vector Map functions for both mission planning and cockpit use are shown below in Figures 3 through 7. The ratings and their associated descriptions are shown below in Table 5:

5.0	Extremely Useful
4.0	Of Considerable Use
3.0	Of Use
2.0	Of Limited Use
1.0	Of No Use

Table 5: Vector Map Functions Ratings Scale

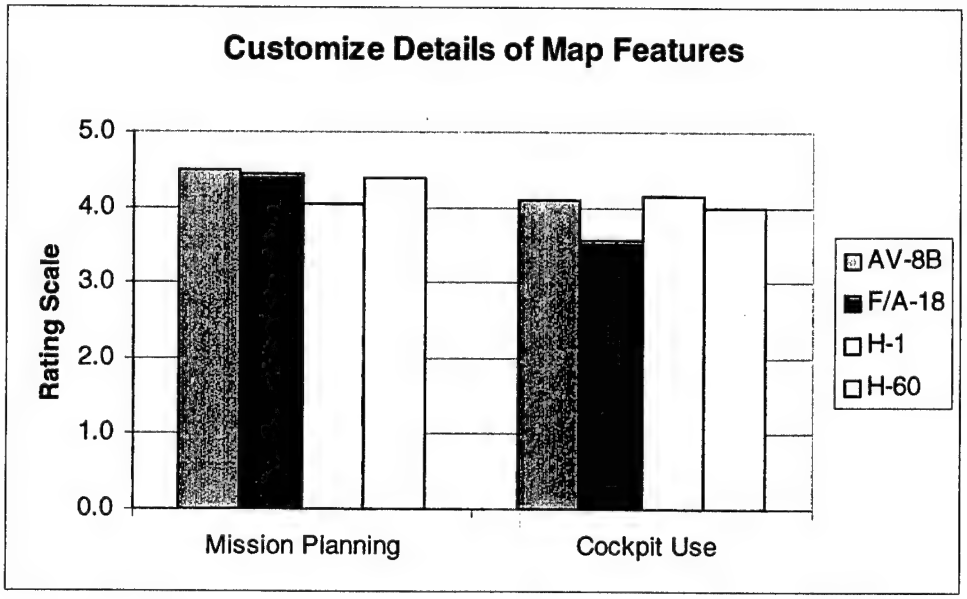

Figure 3: Customize Details of Map Features Function Ratings

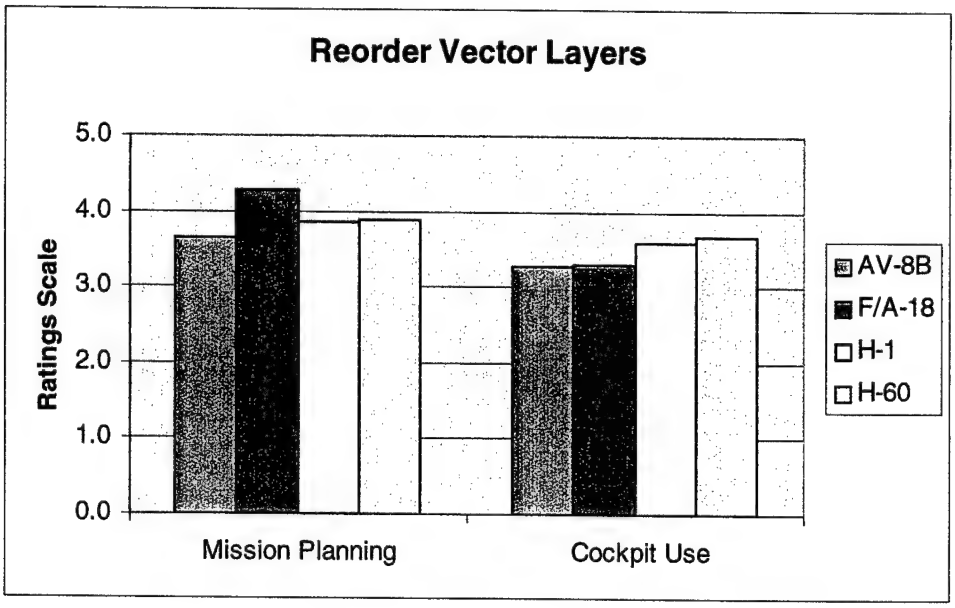

Figure 4: Re-order Vector Layers Function Ratings

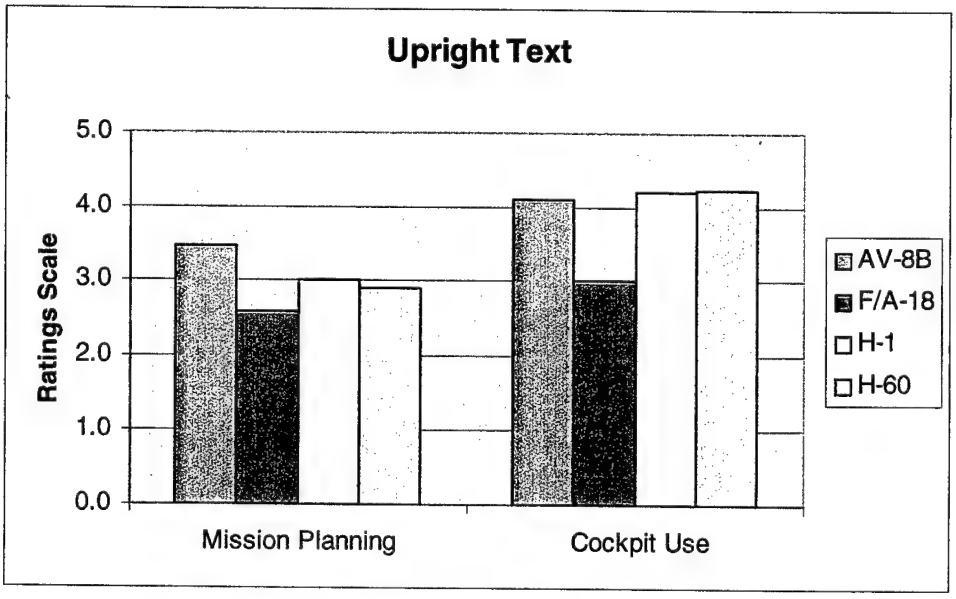

Figure 5: Upright Text Function Ratings

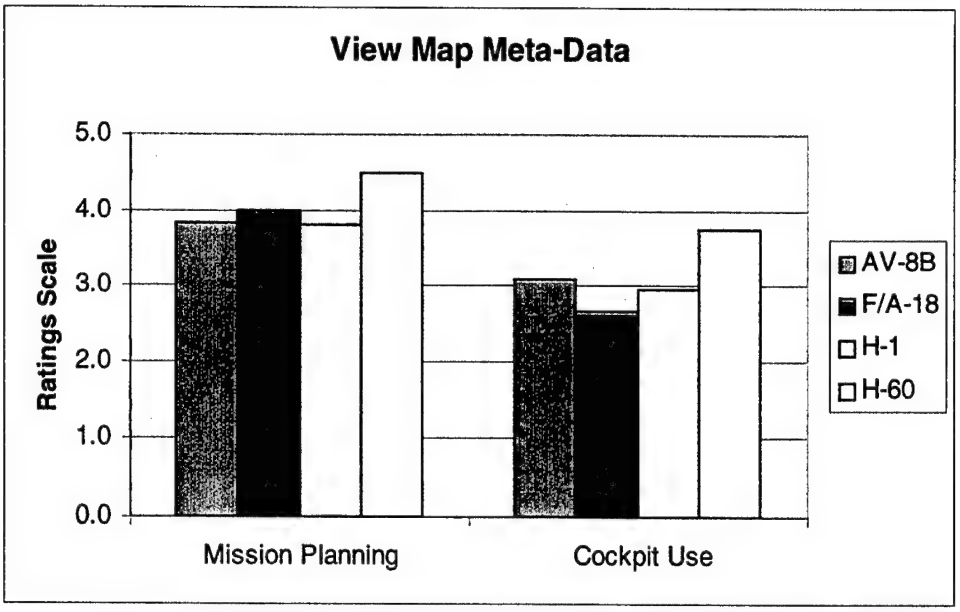

Figure 6: View Map Meta-Data Function Ratings

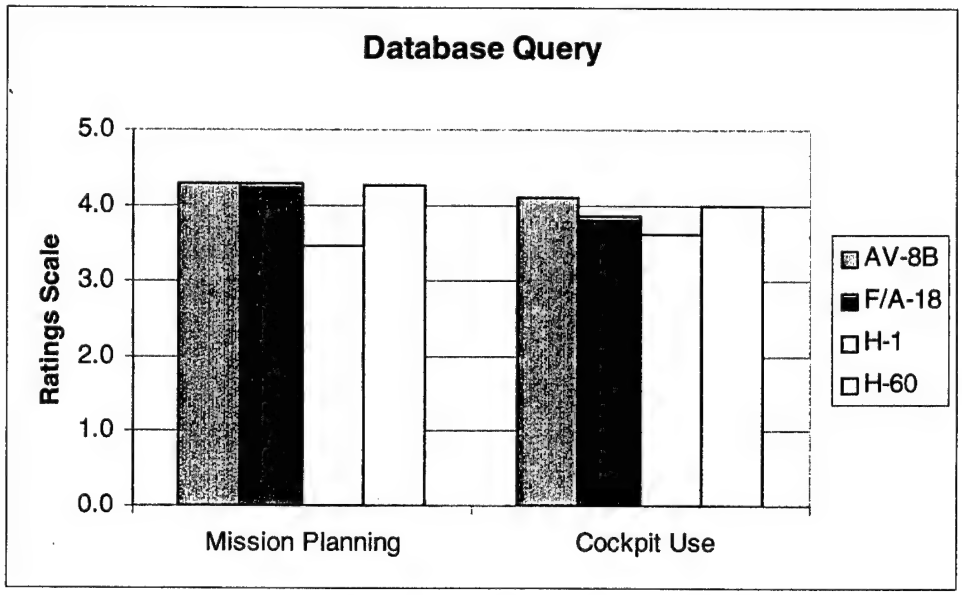

Figure 7: Database Query Function Ratings

Note 3. The preceding Figures do not distinguish between primary and secondary missions WITHIN a platform. With additional data points, it would be beneficial to create a separate bar within the graph for the primary and secondary missions within EACH platform for further discrimination on Mission Planning and Cockpit Use utility ratings (i.e. H-60 Maritime, H-60 Overland/CSAR).

All vector map functions on average were generally rated at least "of use" or higher for both mission planning and cockpit use. Those with the lowest relative rating were the text upright function for mission planning (probably not an issue unless there is a moving map requirement for mission rehearsal), and the F/A-18 rating for the view meta-data function for cockpit use (this is most likely attributable to the F/A-18 participant flight hour experience issue identified earlier).

Overall, there were some differences in vector map function prioritization based on aircrew experience based on number of flight hours. This was primarily limited to the AV-8B and F/A-18 communities. Additional survey participants from these communities will be necessary to assess whether this inconsistency is a result of minimum data points available for analysis or is a result of the diverse background and mission experiences of the Strike/Close Air Support (CAS) community. It is important to note, though, that a majority of the respondents across ALL platforms had significant flight hour experience. In addition, there does not appear to be any correlation between moving map experience and the consistency of the survey results across the platforms. Essentially all the participants were familiar with PFPS, and all the AV-8B and F/A-18 communities were very familiar with the current AN/ASQ-196 and the TAMMAC systems. The H-1 and H-60 communities were familiar with moving map concepts, even though they did not have significant experience with either the AN/ASQ-196 and/or TAMMAC. However, the specific experience with existing or planned moving map systems will most likely become relevant as additional Human Machine Interface (HMI) issues are addressed in follow-on efforts addressing Vector Map integration into cockpit moving map displays.

The actual ratings assigned by the participants for each of the Vector Map functions are detailed in Appendix 1. Primary and Secondary missions listed by the participants are also included for context on the respective ratings.

c. Part 2 Analyses

For the AV-8B, the aircrew participants consistently rated the DTOP, FFD and the VMap vector map data products as most useful. The DNC, LWD, and TOD data products were generally rated as the least useful products. Of those three, the DNC data product had a higher relative priority.

For the F/A-18, the DTOP data product was also consistently rated as most useful followed by the VMap and DNC data products. The LWD and TOD data products were consistently rated as the least useful products.

For the H-1, the DTOP data product was consistently rated as most useful, followed by the FFD and VMap data products. The least useful data products were the DNC and TOD products.

For the H-60, the DNC, LWD, and TOD data products were rated as the most useful products for maritime missions. For the HH-60H CSAR mission, VMap and FFD data products were rated as most useful.

F/A-18 Comment: "*(TOD) data product appears to be beneficial for airspace management during overwater training flights*"

H-1 Comment: "*Vector Maps need to ensure they support both L/L and grid lines that are accessible by the operator*"

H-60 Comment: "*New H-60 mission of AMCM needs to be addressed. LWD and VMap data products, in addition to the DNC data products, may need to incorporate additional detail to support AMCM missions*"

The relative ratings by platform[4] for the utility of each of the five Vector Map products to the platform primary and secondary missions are shown below in Figures 8 through 13. The ratings scale is the same one that is depicted in Table 5.

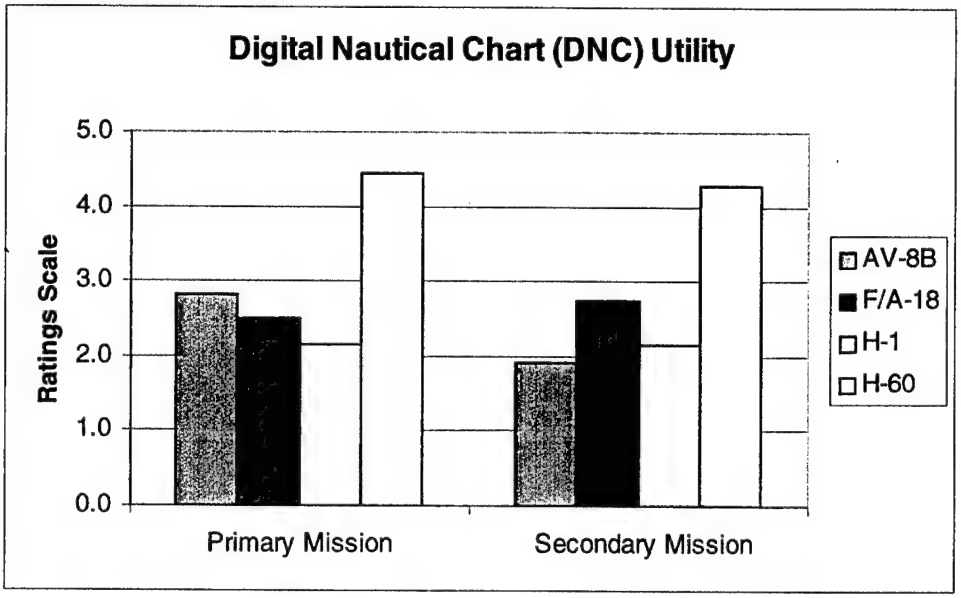

Figure 8: Digital Nautical Chart (DNC) Utility Ratings

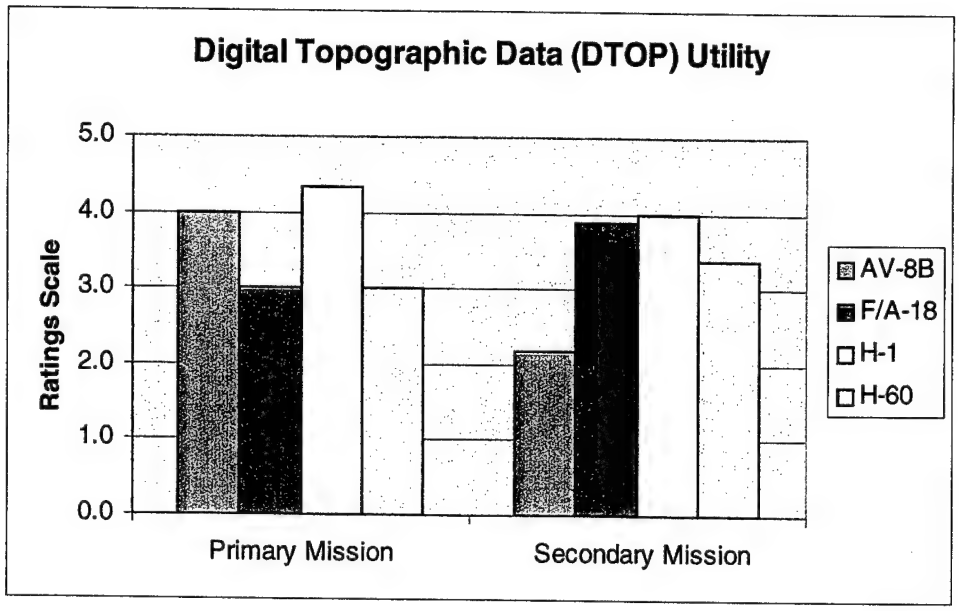

Figure 9: Digital Topographic Data (DTOP) Utility Ratings

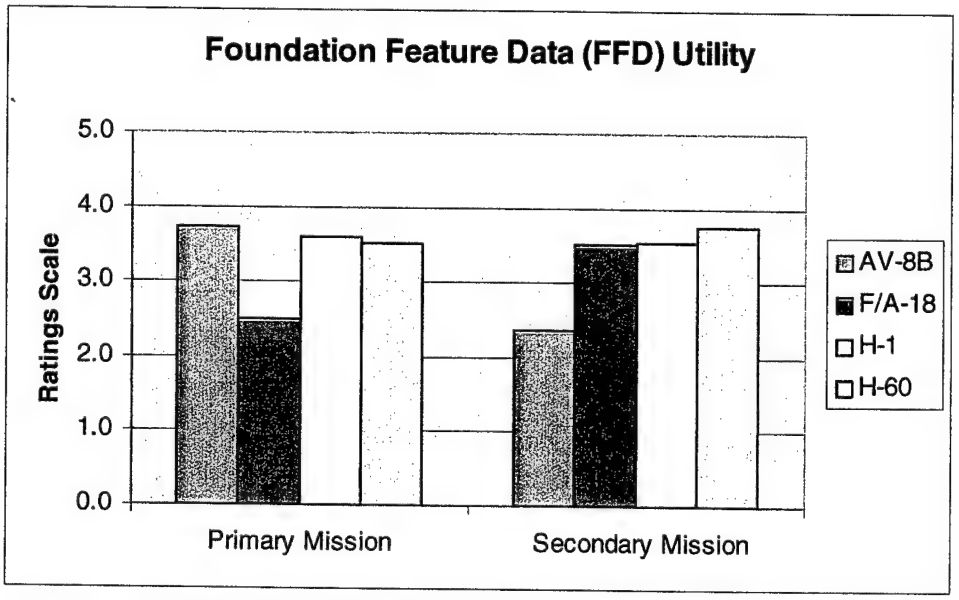

Figure 10: Foundation Feature Data (FFD) Utility Ratings

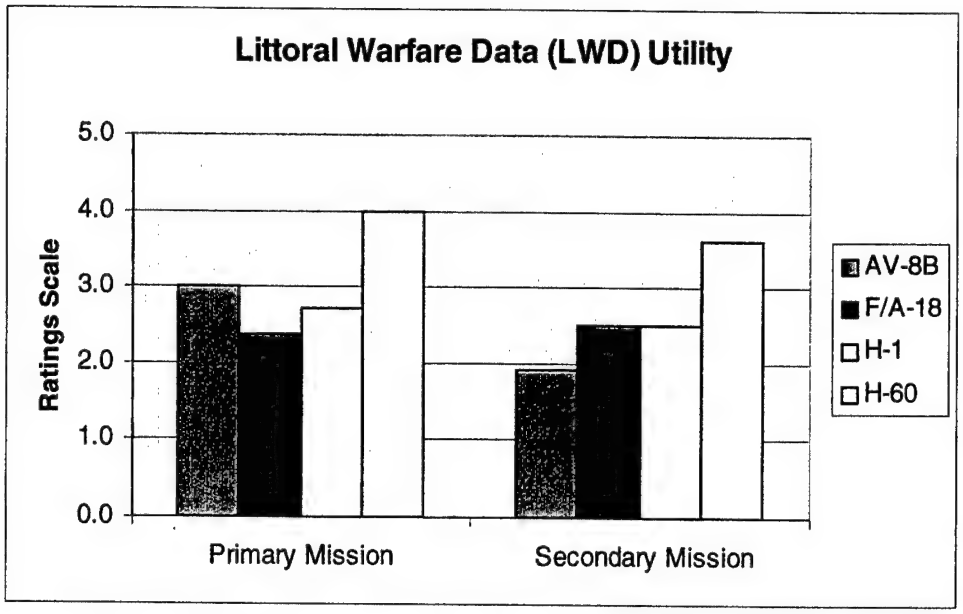

Figure 11: Littoral Warfare Data (LWD) Utility Ratings

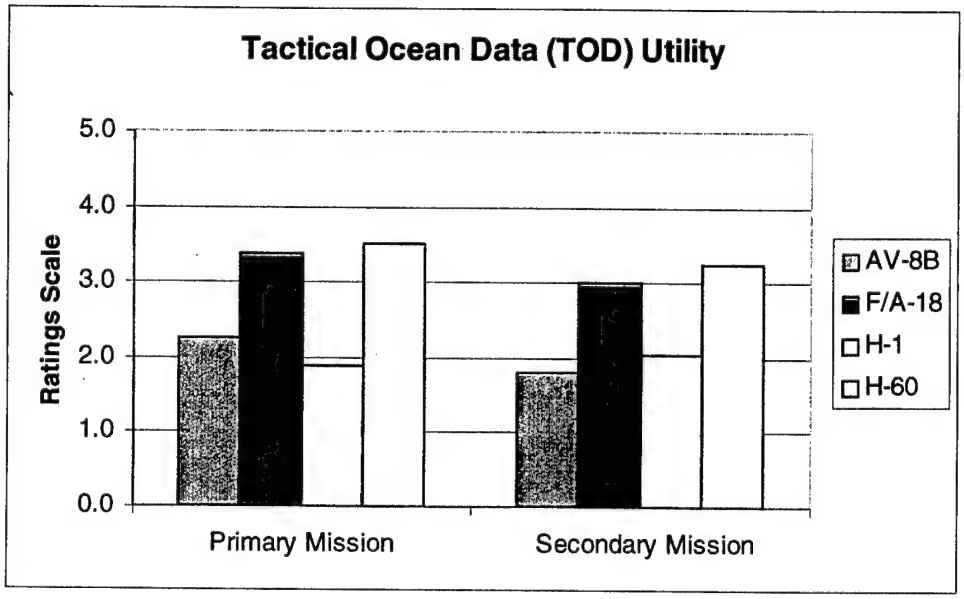

Figure 12: Tactical Ocean Data (TOD) Utility Ratings

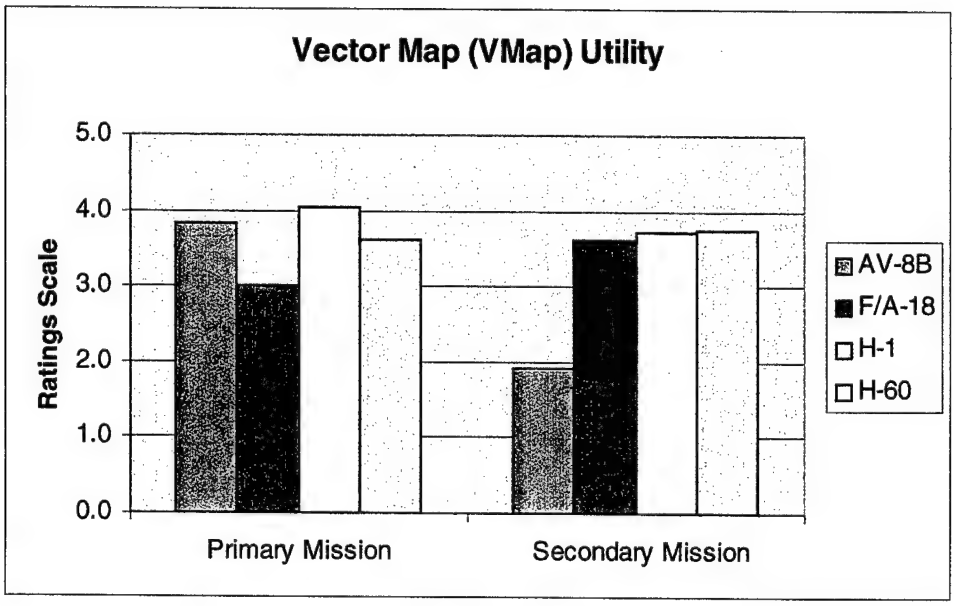

Figure 13: Vector Map (VMap) Utility Ratings

Note 4. With additional data points, it would be beneficial to create an additional bars within each data product graph based on EACH listed platform primary mission (i.e. H-60 Maritime, H-60 Overland/CSAR), allowing further discrimination of data product utility for specific primary platform missions. The current figures are averages across ALL missions within each platform

The actual ratings assigned by the participants for each of the Vector Map data products are detailed in Appendix 2. Primary and Secondary missions listed by the participants are also included for context on the respective ratings.

Conclusions/Recommendations

The following overall conclusions can be drawn from the initial analysis of the data presented[5,6,7] in both Parts 1 and 2:

1. The AV-8B and F/A-18 communities both addressed concerns with task prioritization and workload issues in the cockpit relative to the Vector Map functions outlined in the survey. Customize details of map features and view meta-data functions would allow them to tailor the map display to minimize task saturation, and have access to specific data if necessary. There was also concern about the upright text function and the potential to affect SA. The re-order vector layers and database query functions were seen as potentially task intensive, but the ability to set aircrew profiles during mission planning was highly desired and could mitigate a potential increase in task workload.
2. For the H-1 and H-60 communities, the ability to interact with the moving map during mission execution was highly desired. The high priority assigned to the customize details of map features, re-order vector layers and upright text functions

are consistent with the high priority of map utilization for threat avoidance, terrain avoidance and navigation. The detailed map study during mission planning would reduce the priority for additional map data in flight via the meta-data and database query functions.

3. Among all the participants, but particularly those with lower flight experience, the database query function was seen as a high priority to assist with determination of available bingo or emergency landing airfields.
4. The high prioritization by the AV-8B, F/A-18, and H-1 platforms of DTOP and VMap data products appears to be consistent with Air to Ground Combat (AGC) and FAC(A) mission requirements. In addition, AV-8B and F/A-18 aircrew rated these products as also supportive of Air-to-Air Combat mission requirements.
5. Higher prioritization of DNC data products for F/A-18 appears consistent with their launch/recovery in a maritime environment, in addition to support for F/A-18 maritime missions. This is true to a lesser extent with the AV-8B.
6. H-1 prioritization for the FFD data product appears to be consistent with low-level flight requirements on land, although both AV-8B and F/A-18 rated the FFD data product moderately high for support of AGC missions.
7. H-60 high prioritization for DNC, LWD and TOD data products appear to be consistent with Maritime mission requirements. For the HH-60H CSAR mission, DTOP, FFD, and VMap data products were rated as most useful. This is also consistent with the overland requirements of the CSAR mission.
8. The AV-8B and F/A-18 communities have the most experience with moving maps, including both the current AN/ASQ-196 and TAMMAC. Although the H-1 and H-60 helicopter communities had on average more flight hour experience, both of those communities had less exposure to moving map systems. All communities had significant experience with PFPS/Falconview. In addition, the H-60 community has experience with GADGHT, which uses Falconview.

Note 5: The numbers of AV-8B, F/A-18, and H-60 participants currently are too small to ensure statistical relevance. Additional survey participants from those communities will be required to validate conclusions drawn from the current inputs from those communities.

Note 6: There does not appear to be any immediate correlation between moving map experience and the consistency of the survey results across the platforms.

Note 7: This survey does not include input from the Maritime Patrol Community (P-3C, Multi-Mission Maritime Aircraft (MMA)). However, their input in the future may be useful in addressing other aspects of the Maritime mission that differ from the H-60 maritime warfare perspective.

The following recommendations are made based on the conclusions above:

1. Provide feedback to primary community Points-Of-Contact (POC) on the results of the Vector Map survey, and identify any community issues that are probably of interest based on the survey data provided by the participants.
2. Continue efforts to raise awareness in all Fleet Aviation communities on moving map technologies and current system development status.
3. Continue to have Fleet Aviation communities document requirements for moving map installation aboard their respective platforms, including enhancement to warfighting capabilities (including training).
4. Continue efforts to address advanced HMI concepts with moving maps, addressing HMI comments identified in this survey.

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References

1. Harris Corporation (2001). TAMMAC Digital Map System; URL: http://www.govcomm.harris.com/pdf/505483aSC.pdf.

2. National Imagery and Mapping Agency. Interface Standard for Vector Product Format, MIL-STD-2407. 27 April 1996.

3. National Imagery and Mapping Agency. Military Standard – Compressed ARC Digitized Raster Graphics, MIL-C-89038. 6 October 1994.

4. National Imagery and Mapping Agency. Performance Specification – Controlled Image Base, MIL-PRF-89041. 15 May 1995.

5. National Imagery and Mapping Agency. Performance Specification – Digital Terrain Elevation Database, MIL-PRF-89020A. 19 April 1996.

6. Lohrenz, M.C., Trenchard, M.E., Myrick, S.A. Digital Map Requirements Study in Support of Advanced Cockpit Moving Map Displays. NRL Formal Report – NRL/FR/7441—96-9652. 10 October 1997.

7. Trenchard, M.E., Lohrenz, M.C., Myick, S.A., Gendron, M.L. A Two-part Study on the Use of Bathymetric and Nautical Chart Information in a Moving-Map Display to Support Mine Counter Measures Operations. *Human Performance, Situational Awareness & Automation Conference* (Savannah, GA October 2000).

8. Lohrenz, M.C., Trenchard M.E., Edwards, S.S., Collins, CDR. A Pilot-Centered Evaluation of Geospatial Data for Proposed Navy Helicopter Moving- Map Displays. *Human Computer Interaction – Aerospace Conference* (Cambridge, MA October 2002).

9. National Imagery and Mapping Agency. Performance Specification – Digital Nautical Chart, MIL-PRF-89023. 19 December 1997.

10. National Imagery and Mapping Agency. Performance Specification – Digital Topographic Data, MIL-PRF-0089037. 25 May 1999.

11. National Imagery and Mapping Agency. Associated Performance Specification – Foundation Feature Data, MIL-PRF-89049/1 (DRAFT). 30 November 1998.

12. National Imagery and Mapping Agency. Associated Performance Specification – Littoral Warfare Data, MIL-PRF-89049/7 (DRAFT). 18 May 1998.

13. National Imagery and Mapping Agency. Performance Specification – Tactical Ocean Data – Level 0, MIL-PRF-89049/10. 24 November 1998.

14. National Imagery and Mapping Agency. Performance Specification – Vector Smart Map – Level 0, MIL-PRF-89039. 9 February 1995.

Appendix A. Part 1 Rankings Sorted

Part 1 Vector Map Functions/Page # Cross-Correlation:

05 – Customize Detail of Map Features
06 – Re-order Vector Layers
07 – Upright Text
08 – View Map Meta-Data
09 – Database Query

1. AV-8B:

Registrant ID	First	Second	Third	Fourth	Fifth	Primary Mission	Secondary Mission
19	05	08	09	06	07	AGC	Empty
20	05	07	06	08	09	AAC	AGC
44	05	06	08	09	07	AGC	AAC
47	08	05	06	07	09	AGC	AAC
48	05	06	08	07	09	Close Air Support	Empty
61	05	07	06	09	08	AGC	AAC
62	05	08	07	06	09	AGC	AAC
63	09	06	05	07	08	AGC	AAC
65	09	08	05	07	06	AGC	AAC
72	05	09	07	08	06	AGC	AAC
74	05	07	09	08	06	AGC	AAC

2. F/A-18

Registrant ID	First	Second	Third	Fourth	Fifth	Primary Mission	Secondary Mission
42	08	05	06	09	07	AAC	AGC
49	05	07	09	06	08	AAC	AGC
50	05	06	09	07	08	AAC	AGC
53	08	07	06	09	05	AGC	AAC
56	05	06	08	09	07	AGC	AAC
57	09	07	08	06	05	AAC	AGC
64	08	05	09	06	07	AAC	AGC
67	08	09	06	05	07	AAC	AGC

3. H-1

Registrant ID	First	Second	Third	Fourth	Fifth	Primary Mission	Secondary Mission
24	05	06	07	08	09	FAC(A)	AGC
25	09	05	06	07	08	SI	FAC(A)
26	05	07	08	06	09	AGC	FAC(A)
27	09	05	07	06	08	FAC(A)	AGC
28	05	06	08	09	07	AGC	CSAR
29	05	06	08	09	07	TRNG	FAC(A)
30	05	06	07	08	09	AGC	FAC(A)
31	05	06	09	07	08	AGC	FAC(A)
32	07	05	06	09	08	BD	AGC
34	05	06	07	08	09	AGC	FAC(A)
35	06	05	09	08	07	FAC(A)	Empty
36	05	08	06	07	09	AGC	FAC(A)
39	05	06	09	08	07	AGC	FAC(A)
40	05	07	09	06	08	AGC	FAC(A)
43	08	05	09	07	06	FAC(A)	AGC
45	05	07	06	09	08	AGC	FAC(A)
54	05	07	06	08	09	AGC	FAC(A)
60	07	05	06	08	09	OFFENSIVE AIR SUPPORT (OAS)	FAC(A)

4. H-60

Registrant ID	First	Second	Third	Fourth	Fifth	Primary Mission	Secondary Mission
13	05	06	07	09	08	SSC	ASW
46	05	06	07	09	08	ASW	OTH-T
66	05	07	06	08	09	ASW	SAR
68	05	06	08	09	07	CSAR	SAR
69	05	06	09	08	07	SS	HVBSS
70	08	07	05	09	06	TRNG	CSAR
73	05	06	08	09	07	SAR	CSAR
75	05	07	08	06	09	ASUW	ASW

5. Support

Registrant ID	First	Second	Third	Fourth	Fifth	Primary Mission	Secondary Mission
21	05	08	06	07	09	METOC	N/A

Appendix B. Part 2 Rankings Sorted

Part 2 VPF Data Product Evaluations/Page # Cross-Correlation:
13 - Digital Nautical Chart (DNC)
14 - Digital Topographic Data (DTOP)
15 - Foundation Feature Data (FFD)
16 - Littoral Warfare Data (LWD)
17 - Tactical Ocean Data (TOD)
18 - Vector Map (VMap)

1. AV-8B:

Registrant ID	First	Second	Third	Fourth	Fifth	Sixth	Primary Mission	Secondary Mission
19	15	13	18	14	16	17	AGC	Empty
20	18	13	14	15	17	16	AAC	AGC
44	14	18	15	16	13	17	AGC	AAC
47	15	14	16	17	13	18	AGC	AAC
48	14	18	15	16	13	17	Close Air Support	Empty
61	18	14	15	16	17	13	AGC	AAC
62	18	16	17	15	14	13	AGC	AAC
63	14	15	18	13	16	17	AGC	AAC
65	14	15	18	16	17	13	AGC	AAC
72	13	14	15	16	17	18	AGC	AAC
74	14	15	16	13	18	17	AGC	AAC

2. F/A-18

Registrant ID	First	Second	Third	Fourth	Fifth	Sixth	Primary Mission	Secondary Mission
42	13	14	15	16	17	18	AAC	AGC
49	14	15	17	16	18	13	AAC	AGC
50	18	14	15	13	16	17	AAC	AGC
53	14	13	15	18	17	16	AGC	AAC
56	14	18	13	17	16	15	AGC	AAC
57	18	14	17	15	13	16	AAC	AGC
64	13	14	16	15	18	17	AAC	AGC
67	14	15	18	16	13	17	AAC	AGC

3. H-1

Registrant ID	First	Second	Third	Fourth	Fifth	Sixth	Primary Mission	Secondary Mission
24	18	15	14	16	17	13	FAC(A)	AGC
25	15	14	18	13	16	17	SI	FAC(A)
26	18	14	15	13	16	17	AGC	FAC(A)
27	14	15	18	13	17	16	FAC(A)	AGC
28	14	15	18	13	16	17	AGC	CSAR
29	18	15	14	16	17	13	TRNG	FAC(A)
30	14	18	15	16	13	17	AGC	FAC(A)
31	15	14	18	16	13	17	AGC	FAC(A)
32	18	14	15	16	13	17	BD	AGC
34	14	13	15	17	18	16	AGC	FAC(A)
35	14	18	15	16	13	17	FAC(A)	Empty
36	18	14	13	16	17	15	AGC	FAC(A)
40	14	15	18	16	13	17	AGC	FAC(A)
43	14	18	16	15	13	17	FAC(A)	AGC
45	18	14	15	13	17	16	AGC	FAC(A)
54	18	14	15	16	17	13	AGC	FAC(A)

4. H-60

Registrant ID	First	Second	Third	Fourth	Fifth	Sixth	Primary Mission	Secondary Mission
13	13	16	17	14	15	18	SSC	ASW
46	13	16	17	15	18	14	ASW	OTH-T
66	15	18	14	13	17	16	ASW	SAR
68	14	18	17	16	13	15	CSAR	SAR
69	13	16	18	17	14	15	SS	HVBSS
70	18	15	13	16	17	14	TRNG	CSAR
73	14	18	13	15	17	16	SAR	CSAR
75	13	17	16	14	15	18	ASUW	ASW

5. Support

Registrant ID	First	Second	Third	Fourth	Fifth	Sixth	Primary Mission	Secondary Mission
21	18	15	14	16	13	17	METOC	N/A